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UNITED STATES BUREAU OF MINES
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INFORMATION CIRCULAR

MINING ANTHRACITE WITHOUT ROOF-FALL ACCIDENTS AT COLONIAL COLLIERY, COLONIAL COLLIERY CO., NATALIE, PA.

RECEIVED

BY

R. D. CURRIE

Original from THE OHIO STATE UNIVERSITY

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MINING ANTHRACITE WITHOUT ROOF-FALL ACCIDENTS AT COLONIAL COLLIERY, COLONIAL COLLIERY CO., NATALIE, PA.[1]

By R. D. Currie[2]

INTRODUCTION

Falls of roof have long been the major cause of mine accidents, including fatalities, in both anthracite and bituminous-coal mines of the United States, as well as in coal and metal mines all over the world. In 1932 the Pennsylvania Department of Mines began a concentrated drive to prevent such accidents; through the untiring efforts of most of the anthracite operators and officials, this drive is now showing remarkable results in a lower accident rate from this cause.

One of the most unusual records is that of the Colonial Colliery, Colonial Colliery Co., an anthracite mine and preparation plant at Natalie, Northumberland County, Pa., operated by Madeira, Hill & Co., with main office at 260 S. Broad Street, Philadelphia, Pa.

Mining Conditions, Methods, and Practices at Colonial Colliery

Mining conditions at Colonial Colliery are typical of the Western Middle coal field of the Pennsylvania anthracite region. The mine is opened by 3 shafts and 3 surface slopes, in addition to 5 underground slopes. The 11 veins of coal being mined range from 2.5 to 5 feet in thickness, and the pitch ranges from flat to 65°. The roof overlying the coal is characteristic of coal mines in this region and varies from massive conglomerate to more or less disintegrated shale. The cover ranges from essentially nothing at the outcrop to 500 feet.

The mining methods employed cover the entire range of common operating practices in the region, including longwall, room-and-pillar, buggy breasts, sheet-iron chutes, empty or open chutes on batteries, full chutes or breasts, mechanical shaker chutes, and scraper loaders. The general practice is to carry breasts 24 feet wide on 50-foot centers, although in certain sections breasts are carried 25 feet wide on 30-foot centers.

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[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6783."

[2] Engineer in charge, Scranton (Pa.) Safety Station, U. S. Bureau of Mines.

Longwall mining has been done on an extensive scale; and large areas have been completely mined, using faces or walls 250 to 400 feet long. This method, using Sullivan-type undercutting machines with scraper loaders, has been very successful in the flat portion of the mine.

During 1933, 50.4 percent of the total tonnage came from pillar extraction, and about 40 percent of the total production was loaded by mechanical units. The active workings comprise 278 faces, of which 22 are advancing gangways.

Mechanical Equipment and Machinery

The Colonial Colliery is highly mechanized and uses electric power extensively in mining, loading, and transportation. The following mechanical equipment is used in these three operations: 27 scraper loaders, 61 shaker chutes, 13 storage-battery locomotives, 17 trolley locomotives (7 to 15 tons), 3 outside steam locomotives, 2 outside rock lorries, 1,150 mine cars (steel except 140 wood and steel cars), 4 undercutting machines, and 97 pneumatic drills. Forty miles (2.5 miles on the surface) of track are in use. Mules haul over about 10 miles of track, especially in gathering cars in isolated sections, or for short distances.

Gas and Ventilation

Parts of the mine considered gassy are worked with closed lights; when this report was written 847 Edison models F and H permissible electric cap lamps were in use by 83 percent of the underground employees.

The mine is ventilated on a split system, using 6 electrically driven fans as shown in table 1.

TABLE 1. - Ventilating fans

Size, feet	Capacity, cu. ft. per min.	Size, feet	Capacity, cu. ft. per min.
5 x 12	100,000	4 x 8	35,000
4 x 6	89,000	6 x 18	80,000
3 x $1\frac{3}{4}$	30,000		

All ventilating fans are equipped with automatic panels; 2 are reversible and equipped with explosion doors. Five automatic-type mine doors are used in controlling the ventilation to parts of the mine - 2 electrically and 3 mechanically operated.

In a recent study of the return airways of the mine the samples collected by the writer and analyzed by the gas laboratory of the United States Bureau of Mines indicate that approximately 45,690 cubic feet of methane are carried out of the mine every 24 hours. Although this is not a large quantity of methane for a mine of this size (gas has never been found in over half of the mine sections) nevertheless it is enough to keep the officials on the alert for dangers from this source.

Supervision

Underground supervision of workmen and working places plays a large part in any accident prevention program. While educational methods are stressed and personal responsibility is impressed upon every employee, supervision is carefully maintained at the Colonial Colliery, as shown in table 2.

TABLE 2. - Supervisors at Colonial Colliery

1 superintendent	Inside and outside
1 assistant superintendent	
1 outside foreman	Outside
1 breaker foreman	
1 electrical foreman	
1 carpenter foreman	
1 night foreman	
1 head machinist	
1 night machinist boss	
1 general mine foreman	Inside
8 mine foremen	
4 assistant mine foremen	
14 preshift examination men	
1 topping boss	
1 transportation or bottom boss	

An average of 584 face men and 305 inside company day men (a total of 889) was employed underground during 1933; the outside force included 63 breaker employees and 115 outside company men - a grand total of approximately 1,067 persons employed.

In general, each working place is visited by a fireboss before the men enter the workings and once during the shift by the foreman in charge, although in certain sections of the mine two visits are made during the shift by the foreman in charge.

The vibration method of roof testing is used. The tips of the fingers are placed against the roof and the adjacent roof is struck with a drill or bar; any vibration felt at the finger tips indicates an unsound roof. This method of testing, in conjunction with the "sound" of the roof, is more dependable than relying upon the "drummy" sound alone.

A general practice in this mine is to have the miner stop his work whenever an official enters the working place and test the roof, reporting to the official the condition of the roof just tested. This is an excellent means of training the men in the correct roof-testing method if followed by proper instructions when improper methods are observed.

Timbering

Although no definite, standardized method of timbering is employed at this colliery several methods are used that seem to fill the specific needs of the varying conditions encountered. Timbering instructions are given verbally at the discretion of the immediate supervisory official. Table 3 shows the quantity of timber used at Colonial Colliery in 1932. The vast quantity of timber used in this mine undoubtedly accounts in large measure for the excellent safety record from falls of roof.

TABLE 3. - Timber used at Colonial Colliery in 1932

Size, inches	Linear feet	Size, inches	Linear feet
3	58,266	9	30,789
4	69,468	10	27,939
5	141,165	11	14,873
6	169,583	12	12,546
7	115,241	13	5,313
8	59,028	14	3,115
		15	1,300

Safety Organization

The safety organization at this colliery is centered around a general safety committee composed of the general manager, general superintendent, mine superintendent, department heads, and safety engineer, which meets monthly to study and discuss accident prevention. The accident reports of the investigating committee are read and discussed, and the responsibility for each accident is placed by the general manager.

A second group, which plays an important part in the accident-prevention program, is the mine staff, which meets monthly to discuss accident-prevention and operating problems.

A third group, the mine safety committee, which functions exclusively for the prevention of accidents, comprises 3 miners, 3 timbermen, 1 electrician, 1 outside carpenter, 1 breakerman, 2 bratticemen, 2 inside company men, 1 machinist, the general outside foreman, the general inside foreman, assistant superintendent, superintendent, and a clerk; this group usually meets once a month to discuss unsafe conditions and practices in and about the mine. Members of this committee are chosen by the superintendent because of their interest in safety.

The Colonial Colliery is affiliated with the Holmes Safety Association and has one of the two chapters of that organization in the anthracite region. The meetings of the Holmes chapter are devoted entirely to the safety and welfare of the mining community and constitute a considerable part of the safety program at this mine. They are held each month in the community hall and are attended by the men, women, and children of the community. Outstanding leaders in safety and education work from time to time discuss subjects of local interest; moving pictures are shown; demonstrations of mine safety equipment are given; mine and community accidents are discussed; and entertainment of various kinds is furnished.

Safety Education

The company realizes the prime importance of safety education to accident prevention and has endeavored to have each employee accept personal responsibility for accident prevention rather than depend upon supervisors for his personal safety, thus establishing a spirit of self-reliance which, when of the right type, has incalculable value in the avoidance of accidents.

Every new employee and every man starting a new job is given instructions in the safe method of doing his work and the hazards connected therewith. In addition, two commercial bulletin services dealing with safety are used. On the surface, a large, illuminated bulletin board, which is passed by all employees, carries a new safety poster and a world news service three times a week, and outstanding safety posters from this board are then used on 8 inside bulletin boards, 4 of which are enclosed in glass.

Discipline

Although no definite standard of discipline has been established, the officials have found it necessary at times to penalize employees for violation of safety practices, rules, or orders; in extreme cases, such as direct and willful violations of the mining law, the offender has been discharged. Examples of recent cases are:

1. Penalized by lay-off and refusal of compensation in a case of smoking in a closed-light section of the mine which resulted in gas ignition and injury to the violator - 1 month lay-off.

2. Firing shot without giving warning of his intentions - 2 days lay-off.

3. Using fuse in violation of company rules - 2 men laid off for 1 week.

4. Smoking in closed-light section of mine - 1 week lay-off.

5. Walking up slope while cars were being hoisted - for first offence, laid off 1 week; for second offence, discharged.

6. Not planking manway - 1 week lay-off.

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Accident Reports

All accidents are reported on the standard insurance form issued by the Commonwealth of Pennsylvania, Department of Labor and Industry, Bureau of Workmen's Compensation.

In every case of injury the mine superintendent prepares a memorandum to the foreman in charge of the section calling his attention to the occurrence and requiring an explanation. Every serious or fatal accident and all unusual accident are investigated by a committee comprising the foreman in charge of the section, th mine foreman, and the safety engineer; the report of this investigation is prepared by the safety engineer, who transmits it directly to the general manager. A separate investigation is made by the mine superintendent, who transmits his report to the general superintendent with a copy to the general manager.

In case of fatal or serious accidents, the mine safety committee makes a separate investigation and discusses its findings at the monthly safety meeting.

Insurance

The company is self-insured therefore has keen interest in accident prevention from the standpoint of immediate cost in compensation, medication, and hospitalization, which is sometimes overlooked by companies not self-insured.

First-Aid Training

First-aid training and equipment are maintained. Thirty-six active first-aid men are trained in the Bureau of Mines standard first-aid course and prepared to render assistance in case of injury; in addition, 36 previously trained men are capable of applying first-aid treatment.

First-aid stations or hospitals (10 underground and 2 on the surface) are maintained in each section of the mine at the mine foremen's offices.

The men at this mine who have been trained in first aid appear to be more careful, on the average, than those who have never been trained; it is reported that not one of the 72 trained in first aid has been injured since the first-aid training was completed. This confirms the experience of numerous companies in the mining and allied industries of the United States that a man who has been trained in first aid is less likely to be prone to accidents than a man who has never received such training.

Protective Clothing

The use of protective clothing, including goggles, shoes, and gloves, is advocated by the mine officials, while the use of protective hats is compulsory; this latter type of protection was introduced at the Colonial Colliery in 1929, when 43 protective hats were in use by the 986 underground employees. During that year underground workmen suffered 38 head injuries, entailing a cost of 286 days of lost time and medical and compensation cost to the company of $583.22.

In 1930, 60 protective caps were in use and 37 head injuries sustained by underground employees, resulting in 716 days of lost time and medical and compensation cost of $3,631.70. In 1931, 970 protective caps were in use among the 979 underground employees; 11 head injuries resulted in 19 days of lost time and a cost of $33.39 in compensation and medication. During 1932 there were no head injuries, and to October 31, 1933, there were only 2 such injuries, a great reduction in head injuries, undoubtedly due in large part to the use of protective hats.

Accident Statistics

Table 4 shows the results of a concerted drive toward accident prevention from falls of roof which resulted in complete elimination of this type of accident in this large colliery for more than 23 months.

TABLE 4. - Accident statistics at Colonial Colliery, 1931-33, inclusive

	1931	1932	1933[2]
Number of lost-time accidents.......	147	104	129
Number of fatalities...............	3	1	1
[1]Days lost due to accidents (actual).	1,690	2,680	3,749
Roof-fall accidents.................	26	None	None
[1]Days lost from roof fall accidents..	685	do	do
Head injuries.......................	11	do	2
Compensation cost, roof fall accidents......................	$8,333.88	do	None
Medical cost, roof fall accidents...	$1,037.00	do	do
Production, net tons................	755,797	580,543	513,514
Days worked by colliery.............	235	188	158
Man-hours worked underground........	1,576,297	1,410,106	1,149,675
Employees underground...............	979	928	932

[1] Does not include standard loading for permanent disability or fatality.
[2] To October 31, 1933.

The last roof-fall accident occurred in this mine on November 28, 1931; and from that time to November 13, 1933, when a roof-fall accident ended the period, 1,186,817 tons of coal were mined by 2,648,540 man-hours of exposure without a single accident from this cause.

It will be observed from table 4 that the total medical and compensation cost for roof-fall accidents in 1931 was $9,370.88, with a production of 755,795 net tons of coal, a direct cost of 1.2 cents per ton for accidents of this type. It should be remembered that the direct cost does not begin to cover the entire cost of an accident; in fact, it is now thought that most companies can figure the actual cost at about 5 times the direct cost, which in this case would be 6 cents per ton in 1931 for roof-fall accidents alone.

Nationality and Age of Employees

A tabulation of the nationalities and ages of the employees of this mine reveals a general cross-section of the nationalities employed in anthracite mines; the ages range from 18 to 79 years.

TABLE 5. - Nationality of employees at Colonial Colliery in 1932

National descent[1]	Number	Percent of total	National descent[1]	Number	Percent of total
Polish	211	18.8	Hungarian	24	2.1
Russian	183	16.3	Tyrolean	8	.7
Dutch	147	13.1	Ukrainian	5	.4
Italian	97	8.6	Scottish	4	.3
English	94	8.4	Belgian	3	.3
Slavic	94	8.4	Spanish	3	.3
German	71	6.3	Negro	2	.2
Irish	68	6.0	French	2	.2
Lithuanian	40	3.5	Norwegian	1	.1
Welsh	40	3.5	Prussian	1	.1
Austrian	26	2.3			
		Total..........................		1,124	100

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[1] 94.8 percent are American citizens and 81.3 percent are married.

TABLE 6. - Age of employees at Colonial Colliery in 1932

Age	Number employed	Percent	Number of injuries	Percent
18-20	11	1	20	6.10
21-24	85	7.5	43	13.00
25-29	187	16.4	57	17.30
30-34	182	16.2	49	14.80
35-39	164	14.6	76	23.00
40-44	177	15.7	41	12.40
45-49	147	13.1	23	7.00
50-54	86	7.5	11	3.30
55-59	57	5.1	7	2.20
60-64	21	1.9	2	.60
65-69	5	.5	1	.30
70-74	1	.1	-	-
75-79	1	.1	-	-

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NUMBER OF ACCIDENTS

FATAL	1
SPECIFIC	
LOST TIME OVER 7 DAYS	
LOST TIME, 3 - 7 DAYS	129
LOST TIME, 0 - 2 DAYS	184
TOTAL	314

ACTUAL NUMBER OF DAYS LOST DUE TO ACCIDENTS ____

DAYS LOST DUE TO ACCIDENTS PER 1,000 TONS SHIPPED ____

FREQUENCY RATE

NO. OF LOST-TIME ACCIDENTS PER 1,000,000 MAN-HOURS WORKED ____

SEVERITY RATE

NO. OF DAYS LOST PER 1,000 MAN-HOURS WORKED ____

FOREMAN	NUMBER OF ACCIDENTS																																																TOTAL				%
	Ayers				L. Brennan				J. Brennan				Williams				Lamb				Miles				Umlauf				Cleaver				S'latterb'n				Hossenstein																
CAUSE OF ACCIDENT	FATAL	OVER 2 DAS.	0 - 2 DAS.	TOTAL	FATAL	OVER 2 DAS.	0 - 2 DAS.	TOTAL	FATAL	OVER 2 DAS.	0 - 2 DAS.	TOTAL	FATAL	OVER 2 DAS.	0 - 2 DAS.	TOTAL	FATAL	OVER 2 DAS.	0 - 2 DAS.	TOTAL	FATAL	OVER 2 DAS.	0 - 2 DAS.	TOTAL	FATAL	OVER 2 DAS.	0 - 2 DAS.	TOTAL	FATAL	OVER 2 DAS.	0 - 2 DAS.	TOTAL	FATAL	OVER 2 DAS.	0 - 2 DAS.	TOTAL	FATAL	OVER 2 DAS.	0 - 2 DAS.	TOTAL	FATAL	OVER 2 DAS.	0 - 2 DAS.	TOTAL	FATAL	OVER 2 DAS.	0 - 2 DAS.	TOTAL	FATAL	OVER 2 DAS.	0 - 2 DAS.	TOTAL	
FALL OF ROOF-ROCK OR SLATE																																																					
FALL OF COAL-FACE OR RIB	1			1			1	1			1	1		1		1		1	1	2			1	1																									1	2	4	7	
FALLING OBJECTS		1		1										1	1	2						1	1	2											1	1														3	3	6	
FALLING PERSONS		1		1		4	1	5		3	2	5		1	2	3		2	5	7		6	5	11		1	4	5		3	5	8		2	5	7														23	29	52	
HANDLING COAL OR ROCK		1	2	3		4	5	9		2	2	4		1	4	5		3	3	6		2	4	6		2	1	3			1	1		1	2	3														16	24	40	
HANDLING MATERIAL, TIMBER, ETC.		3	1	4			4	4		3		3						4	5	9		4	7	11		2		2		3		3		4	4	8														23	21	44	
RUSH OF COAL IN CHUTE MANWAYS							1	1		9	1	10																		1		1																		10	2	12	
FLYING MATERIAL - SMALL PARTICLES		1	1	2		1	6	7			5	5			3	3		1	7	8		3	9	12		2		2			6	6		1	5	6														9	42	51	
FLYING OBJECTS - STEEL CHIPS, ETC.						1		1																						1		1																		2		2	
CARS AND MOTORS		2	1	3		2	4	6		4		4			1	1		2	2	4			5	5						2	1	3		2	2	4														14	16	30	
MECHANICAL LOADING							1	1										1	1	2		1		1						3	2	5							1	1										5	5	10	
ANIMALS - MULES & HORSES							1	1																																											1	1	
MACHINERY - CAUGHT IN, ETC.																																		1		1														1		1	
ELECTRICAL SHOCK - BURN																																		1		1														1		1	
EXPLOSIVES - SHOT - FUMES																																																					
GAS EXPLOSION																																																					
CARBIDE EXPLOSION - BURN																		1	1	2														2		2														3	1	4	
STEPPING ON NAILS		1	3	4			1	1			2	2							1	1						1		1							3	3														2	10	12	
TOOLS - GENERAL USE		1	1	2		1	2	3			1	1		3	1	4		3	3	6		3	3	6						2		2		1	8	9			2	2										14	21	35	
NOT CLASSIFIED			4	4										1		1			1	1																														1	5	6	
TOTAL	1	11	13	25		13	27	40		21	14	35		8	12	20		18	30	48		20	35	55		8	5	13		15	15	30		15	30	45			3	3									1	129	184	314	

Figure 1.- Complete accident report, Colonial Colliery, Jan. 1 - Oct. 31, 1933.

COOPERATING WITH THE PENNSYLVANIA DEPARTMENT OF MINES, ROOF-FALL ACCIDENTS IN THE MINES OPERATED BY MADEIRA HILL & CO. WERE REDUCED FROM 52 IN 1931 TO 3 IN 1932. 417,612 TONS OF COAL WERE MINED PER ROOF-FALL ACCIDENT. THIS RECORD CAN ONLY BE IMPROVED BY COMPLETELY ELIMINATING ROOF-FALL ACCIDENTS. YOUR RECORD TO DATE IS AS FOLLOWS:

NO. OF ROOF-FALL ACCIDENTS 1932	FOREMAN	NUMBER OF ROOF-FALL ACCIDENTS													
		JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	1933	
	AYERS	-	-	-	-	-	-	-	-	-	-				
	L. BRENAN	-	-	-	-	-	-	-	-	-	-				
	J. BRENAN	-	-	-	-	-	-	-	-	-	-				
	WILLIAMS	-	-	-	-	-	-	-	-	-	-				
	LAMB	-	-	-	-	-	-	-	-	-	-				
	MILES	-	-	-	-	-	-	-	-	-	-				
	UHLAUF	-	-	-	-	-	-	-	-	-	-				
	CLEAVER	-	-	-	-	-	-	-	-	-	-				

Figure 2.- Chart for recording roof-fall accidents, on display in office of Colonial Colliery.

By dividing the age group into four classes - 18 to 30, 30 to 40, 40 to 50, and 50 to 80 - it is noted that the ratio of accidents to the number employed decreases from 0.424 in the first class - 18 to 30 - to 0.122 in the 50-to 80-year class, indicating that the younger men are more liable to accidents than the older men; also it will be seen that those in the youngest group - 18 to 20 years - comprising only 1 percent of the total number employed, were involved in more than 6 percent of the accidents, and that in 1932 there were approximately 2 accidents for each employee in this group.

An up-to-date record of all accidents, shown on a specially prepared chart, is furnished to the superintendent of each colliery operated by Madeira, Hill & Co., by the safety engineer. This chart (fig. 1) lists accidents according to causes and the seriousness of the injuries for each section in charge of a foreman. Figure 2, showing the number of roof-fall accidents, is kept in the colliery office, where it has aroused considerable interest among the mine officials. The heading on this chart emphasizes the drive being made to reduce the number of roof-fall accidents and indicates that it is being effective, not only at Colonial Colliery but at all collieries operated by Madeira, Hill & Co., where roof-fall accidents were reduced from 52 in 1931 to 3 in 1932.

Conclusion

That roof-fall accidents can be prevented and even eliminated for long periods has been clearly demonstrated at the Colonial Colliery, as well as at several other mines in the anthracite region, especially the St. Clair Coal Co. mine at St. Clair, Pa.; therefore, there is every reason to believe that with the proper safety organization and the concerted effort of all persons connected with the industry this major cause of accidents can be reduced materially or even eliminated in every mine, not only in this region but in all coal mines in the United States.

The Pennsylvania Department of Mines and B. I. Evans, State mine inspector, are to be especially commended for their accident-prevention efforts at Colonial Colliery, as well as at other mines in this region. The Pennsylvania Department of Mines should also be commended for the appropriate bulletins issued from month to month showing the accident standing of the various companies, as this type of competitive activity has a decidedly helpful effect in spurring the effort to avoid accidents.

ACKNOWLEDGMENT

Acknowledgment is made to George J. Jones and William Richards, who furnished the essential data for this report, and to E. H. Suender, who reviewed and approved it for publication.